UNIVERSITÀ DI TRENTO
Dipartimento di Matematica

Manifesto degli Studi del
Corso di Laurea Magistrale in Matematica
a.a. 2025-2026

Approvato dal Consiglio di Dipartimento il 16 Aprile 2025

1. Activation

The Department of Mathematics offers the Master of Science in Mathematics (*Corso di Laurea Magistrale in Matematica)*, belonging to the class "LM-40 - Matematica". This program provides in-depth knowledge and understanding of various areas of advanced mathematics and their connections to other sciences. All courses in the Master of Science in Mathematics are taught in English.

2. Curricula

The Master of Science in Mathematics is organized into four *curricula:*

- **Advanced Mathematics**
- **Cryptography**
- **Mathematics and Statistics for Life and Social Sciences**
- **Teaching and Scientific Communication**

Every student is required to formally choose one of the curricula and follow the corresponding rules as stated in the *Regolamento Didattico della Laurea Magistrale in Matematica.* Advisors of studies are available for each curriculum. Any change of curriculum is subject to verification of the Teaching Committee.

3. Admission requirements

To apply to the Master of Science in Mathematics, a student must meet both formal requirements and demonstrate adequate academic preparation. The following information is required and must be provided according to the instructions on the website:

- The curriculum (or curricula) the applicant is interested in;
- A detailed study plan of the bachelor's degree, including course titles and syllabi;
- An official document from the university that issued the bachelor's degree, reporting in Italian or English the list of courses taken, the grades obtained, and the final degree mark;
- Work and professional experiences;
- Proof of English language proficiency at a B2 level or higher, certified by an internationally recognized organization or the university that issued the bachelor's degree;
- A motivation statement explaining why the applicant wishes to apply to the chosen curriculum of the Master of Science in Mathematics and what they expect from it.

As for the formal requirements, a bachelor's degree of at least three years is mandatory. This degree must ensure a solid foundation in mathematics, including at least linear algebra, mathematical analysis, and some of their applications.

These formal requirements are met by students who hold a bachelor's degree in the class *L-35 – Scienze Matematiche* or a degree with at least 60 credits in MATH sectors. Credits in PHYS (FIS/), STAT (SECS-S/), and INFO/01-A (INF/01) sectors may also be considered for courses with a strong mathematical focus.

The applicant's knowledge and skills are evaluated by the Admission Committee of the Department of Mathematics. This evaluation may include a written examination and/or an interview. Details on the admission procedure can be found on the website.
Students are admitted to one or more of their chosen curricula or to a different one, as decided by the Admission Committee. Some students may be required to follow a specific study plan.

4. Study plan

Students must submit a study plan that meets the requirements of their chosen curriculum, as outlined in the *Regolamento Didattico*. A valid study plan must include at least 120 credits, distributed across the following categories: core courses (*caratterizzanti*), complementary courses (*affini*), free-choice courses (*liberi*), language courses, and Stage/Thesis.
This document presents, for each curriculum, predefined study plans (called tracks) that are suggested to students and approved by default. Students also have the option to create a personalized study plan within their curriculum, provided it complies with the *Regolamento Didattico* and receives approval from the Teaching Committee.
Students are not allowed to repeat activities already completed in their previous academic career.
Through an agreement with the University of Verona, students may propose a study plan that includes courses from the Master's Degree in Mathematics at that university. Additionally, under an agreement with SMI (*Scuola Matematica Interuniversitaria*), students who attend a Summer School and pass the related exam may receive credit recognition, subject to approval by the Teaching Committee.

5. Safety courses

The online courses Health and Safety in the Workplace – General Risk Training (4 hours) and Health and Safety in the Workplace – Specific Risk Training (Low Risk) (4 hours) are mandatory for all students attending courses held in computer and/or teaching labs. These courses are available through Didattica Online. For students enrolled in Experimental Physics Laboratory at High School Level I and/or II, the Specific Risk Training (Low Risk) course is replaced by the Safety in the Laboratory course. This course must be included in the study plan (code 140551). Activities provided by other departments or Stage activities may have additional safety training requirements.

6. Foreign languages

For students already enrolled in the academic year 2024-25
The rules of the Manifesto 2024-25 apply: students are required to get a B2 certificate of English (3CFU). In case the student has already used a B2 certificate of English to get 3CFU in the bachelor's degree, then he/she must obtain 3 CFU with a C1 certificate of English or a B1 certificate of French, German or Spanish or with the course Scientific Writing and Presentations in English.

For students enrolling in the academic year 2025-26
Students are required to obtain 3 CFU by presenting a C1 English certificate or a B1 certificate in French, German, or Spanish, or by completing the course *Scientific Writing and Presentations in English*.

The certification rules are set by CLA. In particular, the score in each skill must be at least 6/10.

7. Important notices

The courses marked with (*) will be offered in the academic year 2025/2026 but not in the academic year 2026/2027. The Core courses and the courses marked with (**) not activated (N.A.) in the academic year 2025/26 will be activated in the academic year 2026/27.

The courses listed in the left-hand column will no longer be offered and will be replaced by the equivalent courses listed in the right-hand column.
Students which have such a course in their study plan do not need to replace it, can take the examination with the old syllabus and register the grade with the old.
Students cannot have both version of these courses in their study plan.

OLD COURSE	**NEW COURSE**
Algebraic Cryptography mod 1	Symmetric cryptography and finite fields
Algebraic Cryptography mod 2	Public-key and post-quantum cryptography
Advanced Cryptography	Advanced Public-key Cryptography
Advanced Coding Theory	Advanced Symmetric Cryptography
Advanced Topics in Biomathematics	Spatial Models in Biology and Epidemiology
Advanced Group Theory	Advanced Algebra
Theoretical Biomechanics (9 CFU)	Theoretical Biomechanics (6CFU) Modelling in Biomechanics (3CFU)

For the students enrolled in the tracks Modelling and Simulation for Biomedical Applications and Modelling, Statistics and Analysis of Biosystems the rules of the Manifesto 2024-25 apply. In particular, the following courses will be activated in 2025-26, but they will no longer be offered in the following academic years:

145428	Computational Haemodynamics	9	72	MATH-05/A	II.1	Lucas Omar Müller
145331	Mathematical Aspects of Bioelectromagnetism and Imaging	6	42	MATH-05/A	II.1	Ana María Alonso Rodríguez

The *curriculum* Advanced Mathematics

Prerequisites

Students are supposed to have a basic knowledge of the following topics and a good understanding of some of them:

- Algebra (groups and rings, ideals, quotients, isomorphism theorems);
- Geometry (general and algebraic topology, topological and differentiable manifolds, projective geometry);
- Complex Analysis (in one variable);
- Measure Theory (Lebesgue measure and integration theory);
- Ordinary Differential Equations and basic examples of Equations (Laplace, heat and wave equations); Functional Analysis (Banach and Hilbert spaces, linear operators);
- Basics of approximation techniques in Numerical Analysis;
- Classical foundations of Mathematical Physics; Probability (axiomatic construction).

Graduates will be in high demand in business-oriented environments, where problem-solving and analytical skills are highly valued. Students can among the following t*racks*:

- ***General Advanced Mathematics***
- ***Advanced Algebra and Geometry***
- ***Calculus of Variations, Partial Differential Equations and Dynamical Systems***

Advanced Algebra and Geometry

This track has a strong focus on Algebra, Geometry and their interactions, such as in algebraic geometry. In particular, a firm grasp of core algebraic and geometric notions will be required, such as groups, rings, multivariate polynomials, linear algebra, projective geometry, topological spaces, functions of one complex variable. Students will have the opportunity to develop a research thesis a on Commutative Algebra, Computational Algebra, Lie Theory, Group Theory, Algebraic Curves, Algebraic Surfaces, Higher Dimensional Algebraic Varieties, Real, Complex and Quaternionic Geometry.
The high specialization of this track makes it well-suited for pursuing PhD studies in Italy or abroad and for applying to international fellowships in Pure and Applied Mathematics.

Calculus of Variations, Partial Differential Equations and Dynamical Systems

This track has a strong focus on subjects as: Calculus of Variations, Partial Differential Equations (mainly theoretical but also numerical), Ordinary Differential Equations and Dynamical Systems.
Beyond the general prerequisites of the Curriculum in Advanced Mathematics, eligible students should have a firm grasp of core topics in Analysis such as: standard notions of ordinary differential equations (linear systems and nonlinear Cauchy problem), basic notions of Partial Differential Equations (Laplace, heat and wave equations, classification), elements of Real Analysis (Lebesgue measure theory, Lebesgue integration theory, L^p spaces), first elements of Banach and Hilbert spaces, basic probability theory, basic differential geometry.

The students of this track will have the possibility to develop a research thesis on Calculus of Variations, Analysis in metric spaces, Dynamical Systems, geometrical aspects of Partial Differential Equations, Nonlinear Partial Differential Equations, Optimal Control, Numerical Analysis of Partial Differential Equations. The high specialization of this track makes it well-suited for pursuing PhD studies in Italy or abroad and for applying to international fellowships in Pure and Applied Mathematics.

The *curriculum* Cryptography

Prerequisites

This curriculum has a strong focus on algebra and its applications to coding theory and cryptography. In particular, a firm grasp of core algebraic notions will be required, such as the notion of groups, rings, multivariate polynomial and the arithmetic of finite fields. The ideal candidate is also expected to have some familiarity with geometry, number theory, and probability.
For the stage-oriented track, also some basic programming notions will be useful, such as conditional statements, loops, and functions, as is a willingness to learn and apply more advanced concepts in unfamiliar programming languages.
For the research-oriented track, more advanced algebra will be useful, such as fluency in Galois theory and number theory.
In this highly specialized curriculum, the students will receive an introduction to modern methods in Computational Algebra, with an emphasis on its main real-life applications:
According to their own inclination, the students are free to choose between two options:

- ***Stage-oriented***
- ***Research-oriented***

Stage-oriented

This track is especially aimed at students who wish to work in a company's security department. Typically, security departments of banks hire our graduates, but IT companies and security-focused firms also find their training highly relevant. This track complements a solid algebraic background with both applied courses, such as Algebraic Cryptography, Applied Cryptography, and Coding Theory and Applications, as well as practical Computer Science courses, such as Java programming (*Laboratorio di Programmazione*) and Introduction to Computer and Network Security.
An internship is available for all students. It can be either external, in a company, or internal, within the Laboratory of Cryptography, on a project proposed by a company.

Research-oriented

This track is especially aimed at students interested in mathematical research in Applied Algebra, with a focus on Cryptography and Coding Theory, who are willing to pursue a PhD in Mathematics in these subjects.

The *curriculum* Mathematics and Statistics for Life and Social Sciences

Prerequisites

Students are supposed to have a basic knowledge on the following topics and a deep comprehension of some of them:

- General Topology;
- Measure Theory (Lebesgue measure and integration theory);
- Functional Analysis (Banach and Hilbert spaces, linear operators, ordinary differential equations, Fourier series);
- Ordinary and Partial Differential Equations
- Numerical Analysis;
- Probability (including its axiomatic construction);
- Mathematical Statistics.
- Some basic programming notions will be useful, as is a willingness to learn and apply different programming languages.

Students are invited to choose between the following options, which are called tracks*:*

- ***Mathematics for Data Science***
- ***Mathematics for Biology and Medicine***
- ***Modelling, Statistics and Analysis in Mathematical Finance***

It is also possible for a student to present a personal study plan that may cover applications of mathematics to different fields such as finance, economics, engineering or others. Such a study plan is subject to approval by the Teaching Committee*.*

Mathematics for Data Science

Students who take this track will have the opportunity to learn the theoretical and computational foundations of Mathematics for Data Science, including advanced tools in Probability, Mathematical Statistics, Machine Learning and Deep Learning. The track equips students with the knowledge and skills needed to tackle challenges in modelling high dimensional and complex data sets, which are frequently encountered in environmental, biological, social and economic fields.
This track is ideal for students seeking a Ph.D. in Statistics, Data Science, Applied Mathematics, Machine Learning, Artificial Intelligence or related fields. Graduates from this track are also highly sought-after by data analysis departments across various industries, including IT, consulting, business, genomics, bioinformatics, medicine, and data-driven research centers.

Mathematics for Biology and Medicine

The goal of the track is to provide students with the ideal toolbox to design, implement, and apply mathematical and statistical models to problems arising in biology, ecology, epidemiology, molecular networks and medicine. To do so, students will develop solid skills in mathematical modeling, statistics, scientific computing, differential equations, continuum mechanics, and numerical analysis. Unique features of this track are the possibility to do an internship and to interact with clinical research in hospitals, universities, research centers, and companies in Italy and abroad.
The skills acquired in the field of modelling and statistics form a solid basis for a PhD in applied mathematics or biomedical sciences and are also highly valued in companies, especially in the pharmaceutical sector.

Modelling, Statistics and Analysis in Mathematical Finance

The program in entirely taught in English. Students are required to acquire expertise in both analytical and stochastic modeling, data analysis, machine learning, and programming. Upon completion of the program, as part of thesis preparation, students are offered internships with companies and the opportunity to collaborate on their thesis with international research institutions.

The *curriculum* Teaching and Scientific Communication

The goal of this curriculum is to cover the knowledge and skills required for teaching mathematics at the secondary school level, as well as for communicating mathematics and science to a broad audience.

Prerequisites

Students are supposed to have a basic knowledge on the following topics and a good comprehension of some of them:

- Algebra (groups and rings, ideals, quotients, isomorphism theorems),
- Geometry (general and algebraic topology, topological and differentiable manifolds, basic projective geometry),
- Physics (mechanics, thermodynamics, electromagnetism),
- Measure Theory (Lebesgue measure and integration theory),
- Ordinary Differential Equations,
- Classical Foundations of Mathematical Physics,
- Probability (including the axiomatic construction) and Statistics.

Curriculum Advanced Mathematics, *Track General Advanced Mathematics*						
Advisor of study: Francesco Serra Cassano						
Code	**Course**	**CFU**	**Hours**	**SSD**	**Sem**	**Lecturer**
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
At least 24 credits in sectors MATH-01/A-MATH-03/A, of which at least 15 in the following table						
145135	Computational Algebra	6	42	MATH-02/A	1	Alessandra Bernardi
145130	Advanced Geometry	9	63	MATH-02/B	1	Roberto Pignatelli
145129	Advanced Analysis	9	63	MATH-03/A	1	Francesco Serra Cassano
The remaining credits in the following table:						
145146	Mathematical Logic	6	42	MATH-01/A	1	Stefano Baratella
145394	Coding Theory and Applications	6	42	MATH-02/A	1	Nadir Murru
145393	Partial Differential Equations (I modulo) Partial Differential Equations (II modulo)	6 3	42 21	MATH-03/A	1 1	Alberto Valli Alessandro Carlotto
At least 15 *credits in sectors MATH-03/B-MATH-05/A from the following table*						
145435	Stochastic Processes	9	63	MATH-03/B	1	Luigi Amedeo Bianchi Stefano Bonaccorsi
145908	Mathematical Physics – Differential Geometric Methods	9	63	MATH-04/A	1	Enrico Pagani
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MATH-04/A	2	Valter Moretti
145152	Numerical Methods for PDEs	6	48	MATH-05/A	2	Robert Nürnberg
COMPLEMENTARY COURSES – Credits in Core and Complementary courses must be at least 75						
Complementary courses can be chosen in the following table:						
145407	Model Theory (*)	6	42	MATH-01/A	2	Stefano Baratella
145156	Set Theory (**)	6	42	MATH-01/A	2	N.A.
145131	Algebraic Geometry I	6	42	MATH-02/B	1	Alessandro Oneto Edoardo Ballico
145132	Algebraic Geometry II (**)	6	42	MATH-02/B	2	N.A.
145506	Algebraic Topology (*)	6	42	MATH-02/B	1	Riccardo Ghiloni
145566	Real Algebraic Geometry (**)	6	42	MATH-02/B	1	N.A.
145557	Advanced Calculus of Variations (**)	6	42	MATH-03/A	2	N.A.
145507	Advanced Topics in Analysis (*)	6	42	MATH-03/A	1	Gian Paolo Leonardi
145434	Fourier Analysis	6	42	MATH-03/A	2	Marco Bonacini
145538	Geometric Analysis	9	63	MATH-03/A	2	Lorenzo Mazzieri
145258	Geometric Measure Theory	6	42	MATH-03/A	2	Andrea Marchese Paolo Bonicatto
145259	Mathematical control theory (**)	6	42	MATH-03/A	1	N.A.
146115	Minimal surfaces	6	42	MATH-03/A	1	Alessandro Carlotto
145159	Stochastic Differential Equations	6	42	MATH-03/B	2	Michele Coghi
146211	Optimal transport	6	42	MATH-03/A	1	Paolo Bonicatto Andrea Marchese
146212	Toric Geometry (*)	6	42	MATH-02/B	2	Luis Eduardo Solá Conde Elisa Postinghel
146213	Dynamical systems (*)	6	42	MATH-03/A	1	Fabio Bagagiolo
146366	Interactive Theorem Proving	6	42	INFO-01/A	2	Roberto Zunino
146367	Mathematics for Quantum Fields	6	42	MATH-04/A	1	Romeo Brunetti
FREE CHOICE COURSES						
The choice of free courses shall be consistent with the selected curriculum. Students may use 3 of these CFU to take an internship, according to the rules of the Regolamento.						
THESIS						
The program concludes either with the defense of an original thesis worth 30 CFU, or with an internship/placement worth 12 CFU followed by an original thesis worth 18 CFU. Students who opt for a 3 CFU internship as part of their elective courses are required to submit an original thesis worth 30 CFU.						

Curriculum Advanced Mathematics, *Track Advanced Algebra and Geometry*

Advisors of study: Roberto Pignatelli, Willem Adriaan De Graaf

Code	Course	CFU	Hours	SSD	Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145135	Computational Algebra	6	42	MATH-02/A	1	Alessandra Bernardi
145130	Advanced Geometry	9	63	MATH-02/B	1	Roberto Pignatelli
145129	Advanced Analysis	9	63	MATH-03/A	1	Francesco Serra Cassano
At least 15 *credits in sectors MATH-03/B-MATH-05/A from the following table*						
145435	Stochastic Processes	9	63	MATH-03/B	1	Luigi Amedeo Bianchi Stefano Bonaccorsi
145152	Numerical Methods for PDEs	6	48	MATH-05/A	2	Robert Nürnberg
145908	Mathematical Physics – Differential Geometric Methods	9	63	MATH-04/A	1	Enrico Pagani
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MATH-04/A	2	Valter Moretti
COMPLEMENTARY COURSES						
At least 33 credits chosen in the following table:						
145407	Model Theory (*)	6	42	MATH-01/A	2	Stefano Baratella
145156	Set Theory (**)	6	42	MATH-01/A	2	N.A.
146368	Advanced Algebra (*)	6	42	MATH-02/A	1	Mima Stanojkovski
145953	Advanced Number Theory (**)	6	42	MATH-02/A	2	N.A.
145131	Algebraic Geometry I	6	42	MATH-02/B	1	Alessandro Oneto Edoardo Ballico
145132	Algebraic Geometry II (**)	6	42	MATH-02/B	2	N.A.
145506	Algebraic Topology (*)	6	42	MATH-02/B	1	Riccardo Ghiloni
145566	Real Algebraic Geometry (**)	6	42	MATH-02/B	1	N.A.
145538	Geometric Analysis	9	63	MATH-03/A	2	Lorenzo Mazzieri
146212	Toric Geometry (*)	6	42	MATH-02/B	2	Luis Eduardo Solá Conde Elisa Postinghel
145146	Mathematical Logic	6	42	MATH-01/A	1	Stefano Baratella
145394	Coding Theory and Applications	6	42	MATH-02/A	1	Nadir Murru

FREE CHOICE COURSES

Students in this track are strongly encouraged to select their elective courses from the MATH-02 sector.
They may also choose courses from the Bachelor's degree program, specifically: *Algebra Commutativa*, *Geometria Differenziale*, *Teoria Algebrica dei Numeri*, *Introduzione alla Geometria Algebrica*, and *Teoria di Galois*, provided they have not already taken a similar course during their undergraduate studies.
Up to 3 CFU may be used to carry out an internship, in accordance with the program regulations (*Regolamento*).

THESIS

The program concludes either with the defense of an original thesis worth 30 CFU, or with an internship/placement worth 12 CFU followed by an original thesis worth 18 CFU. Students who opt for a 3 CFU internship as part of their elective courses are required to submit an original thesis worth 30 CFU.

Curriculum Advanced Mathematics,
Track Calculus of Variations, Partial Differential Equations and Dynamical Systems

Advisors of study: Gian Paolo Leonardi, Francesco Serra Cassano

Code	Course	CFU	Hours	SSD	Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145130	Advanced Geometry	9	63	MATH-02/B	1	Roberto Pignatelli
145129	Advanced Analysis	9	63	MATH-03/A	1	Francesco Serra Cassano
145393	Partial Differential Equations (I modulo) Partial Differential Equations (II modulo)	6 3	42 21	MATH-03/A	1 1	Alberto Valli Alessandro Carlotto
145435	Stochastic Processes	9	63	MATH-03/B	1	Luigi Amedeo Bianchi Stefano Bonaccorsi
145152	Numerical Methods for PDEs	6	48	MATH-05/A	2	Robert Nürnberg
COMPLEMENTARY COURSES – 36 credits chosen in the following table:						
145557	Advanced Calculus of Variations (**)	6	42	MATH-03/A	2	N.A.
145507	Advanced Topics in Analysis (*)	6	42	MATH-03/A	1	Gian Paolo Leonardi
145142	Foundations of Analysis (*)	6	42	MATH-03/A	2	Fabio Bagagiolo
145434	Fourier Analysis	6	42	MATH-03/A	2	Marco Bonacini
145538	Geometric Analysis	9	63	MATH-03/A	2	Lorenzo Mazzieri
145258	Geometric Measure Theory	6	42	MATH-03/A	2	Andrea Marchese Paolo Bonicatto
145259	Mathematical control theory (**)	6	42	MATH-03/A	1	N.A.
146115	Minimal surfaces	6	42	MATH-03/A	1	Alessandro Carlotto
145159	Stochastic Differential Equations	6	42	MATH-03/B	2	Michele Coghi
145908	Mathematical Physics – Differential Geometric Methods	9	63	MATH-04/A	1	Enrico Pagani
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MATH-04/A	2	Valter Moretti
146211	Optimal transport	6	42	MATH-03/A	1	Paolo Bonicatto Andrea Marchese
146213	Dynamical systems (*)	6	42	MATH-03/A	1	Fabio Bagagiolo

FREE CHOICE COURSES

Students in this track are strongly encouraged to select their elective courses from the MATH-03/A sector.
They may also choose courses from the Bachelor's degree program, specifically: *Equazioni Differenziali Ordinarie*, *Calcolo delle Variazioni*, *Analisi Funzionale*, or *Geometria Differenziale*, provided they have not already taken a similar course during their undergraduate studies.
Up to 3 CFU may be used to carry out an internship, in accordance with the program regulations (*Regolamento*).

THESIS

The program concludes either with the defense of an original thesis worth 30 CFU, or with an internship/placement worth 12 CFU followed by an original thesis worth 18 CFU. Students who opt for a 3 CFU internship as part of their elective courses are required to submit an original thesis worth 30 CFU.

Curriculum Cryptography, *Track Stage-Oriented*						
Advisor of study: Marco Calderini						
Code	**Course**	**CFU**	**Hours**	**SSD**	**Year – Sem**	**Lecturer**
MANDATORY						
Foreign language (3CFU) – a C1 certificate of English is highly recommended						
CORE COURSES						
146369	Symmetric cryptography and finite fields	6	48	MATH-02/A	I.1	Marco Calderini Irene Villa
146370	Public-key and post-quantum cryptography	6	48	MATH-02/A	I.2	Federico Pintore Irene Villa
145394	Coding Theory and Applications	6	42	MATH-02/A	I.1	Nadir Murru
145135	Computational Algebra	6	42	MATH-02/A	I.1	Alessandra Bernardi
145157	Stochastic Processes (I modulo)	6	42	MATH-03/B	1	Sonia Mazzucchi
145427	Scientific Computing	9	72	MATH-05/A	2	Robert Nürnberg
COMPLEMENTARY COURSES						
The following four courses:						
145508	Advanced Programming of Cryptographic Methods	6	48	INFO-01/A	II.1	Silvio Ranise
145937	Introduction to computer and network security	6	48	IINF-05/A	I.1	Mut DISI (0517H – cod. 145937)
145777	Applied Cryptography	6	42	MATH-02/A	I.1	Marco Calderini Federico Pintore
146266	Cryptographic Protocols for Secure Networks and Applications	6	42	IINF-05/A	I.2	Silvio Ranise
At least 12 credits in the following table:						
145451	Computability and computational complexity	6	48	MATH-01/A	1	Mut DISI (0517H – cod. 145451)
146370	Advanced Symmetric Cryptography	6	42	MATH-02/A	2	Massimiliano Sala
146372	Advanced Public-key Cryptography	6	42	MATH-02/A	II.1	Massimiliano Sala
145953	Advanced Number Theory (**)	6	42	MATH-02/A	2	N.A.
145212	Discrete Fourier Analysis (**)	6	42	MATH-02/A	2	N.A.
145256	Statistics of Stochastic Processes	6	48	MATH-03/B	1	Claudio Agostinelli
146373	Quantum information	6	42	MATH-03/B	1	Sonia Mazzucchi
145614	Multimedia Data Security	6	48	IINF-03/A	1	Mut DISI (0346H – 145614)
145190	Digital Signal Processing	6	48	IINF-03/A	1	Mut DISI (0346H – cod. 146224 mod. 1)
146318	Automated Reasoning and Formal Verification	12	96	IINF-05/A	2	Mut DISI (0517H – cod. 146318)
146157	Blockchain	6	48	INFO-01/A	2	Mut DISI (0517H - cod. 146157)
FREE CHOICE COURSES						
To complement their preparation in this track, students who did not take Java programming courses during their Bachelor's studies are strongly encouraged to attend the course *Laboratorio di Programmazione*. Other recommended courses from the Bachelor's program include *Teoria Algebrica dei Numeri* and *Teoria di Galois*.						
THESIS						
The program concludes either with the defense of an original thesis worth 30 CFU, or with an internship/placement worth 12 CFU followed by an original thesis worth 18 CFU.						

Curriculum Cryptography, *Track Research-Oriented*						
Advisor of study: Marco Calderini						
Code	**Course**	**CFU**	**Hours**	**SSD**	**Year – Sem**	**Lecturer**
MANDATORY						
Foreign language (3CFU) – a C1 certificate of English is highly recommended						
CORE COURSES						
146369	Symmetric cryptography and finite fields	6	48	MATH-02/A	I.1	Marco Calderini Irene Villa
146370	Public-key and post-quantum cryptography	6	48	MATH-02/A	I.2	Federico Pintore Irene Villa
145394	Coding Theory and Applications	6	42	MATH-02/A	I.1	Nadir Murru
145135	Computational Algebra	6	42	MATH-02/A	I.1	Alessandra Bernardi
Students can choose between the following two pairs:						
145256	Statistics of Stochastic Processes	6	48	MATH-03/B	1	Claudio Agostinelli
145435	Stochastic Processes	9	63	MATH-03/B	1	Luigi Amedeo Bianchi Stefano Bonaccorsi
Or:						
145157	Stochastic Processes (I modulo)	6	42	MATH-03/B	1	Sonia Mazzucchi
145907	Mathematical Physics – Quantum relativistic Theories	9	63	MATH-04/A	2	Valter Moretti
COMPLEMENTARY COURSES						
The following three courses:						
146372	Advanced Public-key Cryptography	6	42	MATH-02/A	II.1	Massimiliano Sala
146370	Advanced Symmetric Cryptography	6	42	MATH-02/A	2	Massimiliano Sala
146373	Quantum information	6	42	MATH-03/B	1	Sonia Mazzucchi
At least 18 credits in the following table:						
146368	Advanced Algebra (*)	6	42	MATH-02/A	1	Mima Stanojkovski
145953	Advanced Number Theory (**)	6	42	MATH-02/A	2	N.A.
145131	Algebraic Geometry I	6	42	MATH-02/B	1	Alessandro Oneto Edoardo Ballico
145777	Applied Cryptography	6	42	MATH-02/A	I.1	Marco Calderini Federico Pintore
145212	Discrete Fourier Analysis (**)	6	42	MATH-02/A	2	N.A.
FREE CHOICE COURSES						
Students in this track are strongly encouraged to choose their elective courses from the MATH-02/A sector. Courses may also be selected from the Bachelor's program; *Algebra Commutativa*, *Teoria Algebrica dei Numeri*, and *Teoria di Galois* are particularly recommended.						
THESIS						
The program concludes either with the defense of an original thesis worth 30 CFU, or with an internship/placement worth 12 CFU followed by an original thesis worth 18 CFU.						

Curriculum Mathematics and Statistics for Life and Social Sciences, *Track Mathematics for Data Science*

Advisor of study: Veronica Vinciotti

Code	Course	CFU	Hours	SSD	Year Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145905	Geometry and Topology for Data Analysis	6	42	MATH-02/B	I.2	Alessandro Oneto
145435	Stochastic Processes	9	63	MATH-03/B	1	Luigi Amedeo Bianchi Stefano Bonaccorsi
145427	Scientific Computing	9	72	MATH-05/A	I.2	Robert Nürnberg
145256	Statistics of stochastic processes	6	48	MATH-03/B	II.1	Claudio Agostinelli
One course among the following:						
145145	Mathematical Biology	9	72	MATH-03/A	I.1	Simone Pezzuto Cinzia Soresina
145538	Geometric Analysis	9	63	MATH-03/A	2	Lorenzo Mazzieri
COMPLEMENTARY COURSES						
145909	Tensor Decomposition for Big Data Analysis	6	42	MATH-02/A	I.1	Alessandra Bernardi
145902	Advanced Statistical Methods	6	42	MATH-03/B	I.2	Claudio Agostinelli
145561	Bayesian Statistics	6	42	MATH-03/B	I.2	Pier Luigi Novi Inverardi
145914	Statistical Models	6	42	MATH-03/B	I.1	Veronica Vinciotti
146049	Graphical Models and Network Science	6	42	MATH-03/B	II.1	Veronica Vinciotti
One course among the following:						
145434	Fourier Analysis	6	42	MATH-03/A	II.2	Marco Bonacini
145159	Stochastic Differential Equations	6	42	MATH-03/B	I.2	Michele Coghi
FREE CHOICE COURSES						
Knowledge of probability theory and mathematical statistics is essential. Please check the syllabus of the courses: Calcolo delle probabilita II and Statistica matematica (Bachelor's degree in Italian) to ensure that all the topics are covered at the requested level of depth. Students missing these prerequisites will have to include here the aforementioned courses.						
146373	Quantum information	6	42	MATH-03/B	1	Sonia Mazzucchi
145152	Numerical Methods for PDEs	6	48	MATH-05/A	2	Robert Nürnberg
146213	Dynamical systems (*)	6	42	MATH-03/A	1	Fabio Bagagiolo
146214	Markov Decision Processes and Reinforcement Learning	6	48	MATH-03/B	1	Francesco Giuseppe Cordoni
146211	Optimal transport	6	42	MATH-03/A	1	Paolo Bonicatto Andrea Marchese
145903	Deep Learning	6	48	INFO-01/A	2	Mut DISI (0342H – cod.145857 Machine Learning (mod. II))
145062	Machine Learning	6	48	INFO-01/A	1	Mut DISI (0517H – cod. 145062)
THESIS						
The program concludes either with the defense of an original thesis worth 30 CFU, or with an internship/placement worth 12 CFU followed by an original thesis worth 18 CFU.						

Curriculum Mathematics and Statistics for Life and Social Sciences, *Track Mathematics for Biology and Medicine*

Advisor of study: Simone Pezzuto

Code	Course	CFU	Hours	SSD	Year Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
The following five courses						
145145	Mathematical Biology	9	72	MATH-03/A	I.1	Simone Pezzuto Cinzia Soresina
145139	Partial Differential Equations	6	42	MATH-03/A	I.1	(condivide 6 CFU con l'a.d. 145393 I mod)) Alberto Valli
145914	Statistical Models	6	42	MATH-03/B	I.1	Veronica Vinciotti
145427	Scientific Computing	9	72	MATH-05/A	I.2	Robert Nürnberg
145152	Numerical Methods for PDEs	6	48	MATH-05/A	I.2	Robert Nürnberg
COMPLEMENTARY COURSES						
At least five courses from the following list:						
146374	Spatial Models in Biology and Epidemiology	6	48	MATH-04/A	I.2	Cinzia Soresina
145136	Data Analysis and Exploration	6	48	INFO-01/A	I.2	Mario Lauria
145910	Network Modeling and Simulation	6	48	INFO-01/A	I.1 / II.1	Mut QCB (0521H – Mathematical Modeling and Simulation mod. Network Modeling and Simulation a.d. 146089)
146375	Inverse Problems in Biology and Medicine (**)	6	42	MATH-05/A	II.1	N.A.
146376	Computational Haemodynamics (**)	6	48	MATH-05/A	II.1	N.A.
146248	Cardiac Modelling	6	48	MATH-05/A	I.2	Simone Pezzuto
146377	Theoretical Biomechanics	6	48	CEAR-01/A	I.1	Davide Bigoni Luigi Fraccarollo
145561	Bayesian Statistics	6	42	MATH-03/B	I.2	Pier Luigi Novi Inverardi
At least one of the following:						
145392	Physiological flow and transport in porous tissues	6	42	CEAR-01/B	II.1	Alberto Bellin
146378	Applications of Mathematics to Biology and Medicine (**)	6	42	MATH-05/A	II.1	N.A.
146049	Graphical Models and Network Science	6	42	MATH-03/B	II.1	Veronica Vinciotti
145157	Stochastic Processes (I modulo)	6	42	MATH-03/B	I.1 / II.1	Sonia Mazzucchi
FREE CHOICE COURSES						
Students are suggested to take the free courses among those listed above and not already chosen. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include here appropriate courses (in Italian) from the Bachelor's degree.						
146200	Digital Epidemiology	6	48	IINF-05/A	I.2	Mut. DISI (0346H – cod. 146200)
145903	Deep Learning	6	48	INFO-01/A	I.2	Mut DISI (0342H – cod.145857 Machine Learning (mod. II))
146379	Modelling in Biomechanics	3	24	CEAR-01/A	I.1	Davide Bigoni Luigi Fraccarollo
145434	Fourier Analysis	6	42	MATH-03/A	I.2	Marco Bonacini
145338	Bio-Medical Imaging	6	48	PHYS-06/A	I.2	Mut. FIS (0518H - cod. 145338)
145259	Mathematical Control Theory (**)	6	42	MATH-03/A	I.1 / II.1	N.A.
146213	Dynamical systems (*)	6	42	MATH-03/A	I.1 / II.1	Fabio Bagagiolo
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

Curriculum Mathematics and Statistics for Life and Social Sciences, *Track Modelling, Statistics and Analysis in Mathematical Finance*						
Advisor of study: Michele Coghi						
Code	**Course**	**CFU**	**Hours**	**SSD**	**Year – Sem**	**Lecturer**
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
CORE COURSES						
145139	Partial Differential Equations	6	42	MATH-03/A	1	(condivide 6 CFU con l'a.d. 145393 I mod)) Alberto Valli
145145	Mathematical Biology	9	72	MATH-03/A	I.1	Simone Pezzuto Cinzia Soresina
145256	Statistics of Stochastic Processes	6	48	MATH-03/B	II.1	Claudio Agostinelli
145435	Stochastic Processes	9	63	MATH-03/B	I.1	Luigi Amedeo Bianchi Stefano Bonaccorsi
At least one of the following						
145152	Numerical Methods for PDEs	6	48	MATH-05/A	I.2	Robert Nürnberg
145427	Scientific Computing	9	72	MATH-05/A	I.2	Robert Nürnberg
COMPLEMENTARY COURSES						
The following two courses						
145914	Statistical Models	6	42	MATH-03/B	I.1	Veronica Vinciotti
145159	Stochastic Differential Equations	6	42	MATH-03/B	I.2	Michele Coghi
The remaining CFU among the following						
145905	Geometry and Topology for Data Analysis	6	42	MATH-02/B	I.2	Alessandro Oneto
145902	Advanced Statistical Methods	6	42	MATH-03/B	I.2	Claudio Agostinelli
145561	Bayesian Statistics	6	42	MATH-03/B	I.2	Pier Luigi Novi Inverardi
146213	Dynamical systems (*)	6	42	MATH-03/A	1	Fabio Bagagiolo
146214	Markov Decision Processes and Reinforcement Learning	6	48	MATH-03/B	1	Francesco Giuseppe Cordoni
145991	Applied Stochastic Processes	6	42	MATH-03/B	2	N.A.
145912	Scientific Programming	6	48	INFO-01/A	1	Mut QCB (0521H Scientific programming – mod. Programming – cod. 145540)
121395	Financial markets and economic activity	6	36	ECON-01/A	1	Mut DEM (0119H – cod. 121395)
121469	Mercati e Intermediari Finanziari Progredito	10	60	ECON-09/B	2	Mut DEM (0122H – cod. 121469)
121470	Strumenti di Investimento e Derivati	10	60	ECON-09/B	1	Mut DEM (0122H – cod. 121470)
121414	Workshop on Financial simulation	6	36	STAT-02/A	1	Mut DEM (0122H – cod. 121414)
FREE CHOICE COURSES						
Students are suggested to take the free courses among those listed above and not already chosen. For students missing some prerequisites in mathematical analysis or probability theory, it is possible to include here appropriate courses (in Italian) from the Bachelor's degree.						
THESIS						
The course of studies is concluded either with the discussion of an original thesis, providing 30 CFU or with an internship/placement, which assigns 12 CFU, followed by an original thesis providing 18 CFU.						

Curriculum Teaching and Scientific Communication

Advisor of study: Luigi Amedeo Bianchi

Code	Course	CFU	Hours	SSD	Sem	Lecturer
MANDATORY						
Foreign language (3CFU) – See the introduction, point 6						
145151	Mathematical models for the Physical, Natural and Social Sciences (**Core course**)	6	42	MATH-03/B	1	Luigi Amedeo Bianchi Francesco Cordoni (P60 Modelli matematici per la scuola secondaria di II grado)
145155	Modern Physics (**Complementary course**)	12	84	PHYS-06/B	1+2	Giovanni Andrea Prodi
OTHER CORE COURSES – At least 30 credits						
145146	Mathematical Logic	6	42	MATH-01/A	1	Stefano Baratella
145135	Computational Algebra	6	42	MATH-02/A	1	Alessandra Bernardi
145253	Foundations of Geometry	6	42	MATH-02/B	2	Marco Andreatta
145904	Elementary Mathematics from a Higher Viewpoint	6	42	MATH-01/B	1	Elisa Postinghel
145144	Laboratory of Didactics of Mathematics	6	42	MATH-01/B	2	Docente da definire
145154	Experimental Mathematics Laboratory at School Level	6	42	MATH-01/B	1	Silvano Delladio (P60 Laboratorio di sviluppo e approfondimento di attività per la didattica della matematica I-II)
145142	Foundations of Analysis	6	42	MATH-03/A	2	Fabio Bagagiolo
COMPLEMENTARY COURSES – At least one of the two courses						
145153	Experimental Physics Laboratory at High School Level I	6	56	PHYS-06/B	1	Pasquale Onorato
145215	Experimental Physics Laboratory at High School Level II	6	56	PHYS-06/B	2	Pasquale Onorato
OTHER COMPLEMENTARY COURSES – At least 12 credits chosen in the following table or among the courses not chosen from the previous tables						
145906	Laboratory Techniques for Mathematics Teaching	6	56	MATH-01/B	1	Elisabetta Ossanna (P60 Metodi e contenuti per la didattica della matematica I - II)
145914	Statistical Models	6	42	MATH-03/B	1	Veronica Vinciotti
146366	Interactive Theorem Proving	6	42	INFO-01/A	2	Roberto Zunino
OTHER COMPLEMENTARY COURSES – At most 6 credits						
Students may choose courses in the MATH-, PHYS/, or INFO-01 sectors offered by Master's degree programs at the University of Trento or by the Master's degree program in Mathematics at the University of Verona.						
FREE CHOICE COURSES						
Students may use 3 of these CFU to take an internship, according to the rules of the Regolamento.						
THESIS						
The program concludes either with the defense of an original thesis worth 30 CFU, or with an internship/placement worth 12 CFU followed by an original thesis worth 18 CFU. Students who choose a 3 CFU internship as part of their elective courses are required to complete an original thesis worth 30 CFU.						

Appendix A – Glossary

- Credit = Credito formativo universitario = CFU
- This is the European unit used to measure the value of academic activities such as courses, internships, or theses. One credit corresponds to approximately 7 hours of lectures and a total of 25 hours of student work. A Master's degree requires 120 CFU.
- Sector = Settore scientifico-disciplinare = SSD
  This is a nation-wide classification of University courses, sorted out in various categories. The categories (SSD) for Mathematics are the following:

SSD		
MATH-01/A	Logica Matematica	Mathematical Logic
MATH-01/B	Matematiche complementari	Didactics and History of Mathematics
MATH-02/A	Algebra	Algebra
MATH-02/B	Geometria	Geometry
MATH-03/A	Analisi matematica	Mathematical Analysis
MATH-03/B	Probabilità e statistica matematica	Probability and Mathematical Statistics
MATH-04/A	Fisica matematica	Mathematical Physics
MATH-05/A	Analisi numerica	Numerical Analysis

  For other sectors see http://www.miur.it/UserFiles/115.htm
- *Curriculum* (pl. curricula)
- Within the general framework of the Master of Science in Mathematics, students may choose among different curricula: *Advanced Mathematics*, which focuses on in-depth study of advanced mathematical topics; *Teaching and Scientific Communication*, which emphasizes education and science outreach; *Mathematics and Statistics for Life and Social Sciences*; and *Cryptography*. Each curriculum has its own specific rules for course selection.
- *Study plan (Piano di studi)*
- Each student of the Master of Science in Mathematics must specify their course choices in a document with this name. The plan must include a required number of CFU in *caratterizzanti* (Core) courses and in *affini* (Complementary) courses, distributed across the relevant subject sectors.
- *Track* = suggested study plan
  Examples of possible study plans centered on different aspects of mathematical studies.
- *Stage*: the Italian term (actually borrowed from French) for an internship.
- *Semester* (shortened in sem.)
- Teaching is organized into two periods, conventionally referred to as semesters—each lasting approximately 14 weeks, despite the name suggesting six months. The first semester begins in mid-September and ends just before Christmas. The second semester runs from mid-February to the beginning of June
- Corso mutuato = *Mut*
  This is a course which is offered by a different Department or is a proxy for a course held in a different Department.
- N.A. = Not Available
  A course that has been active in previous years, and may well be active again in the future, but is not currently offered.